THE MEMPHIS DEPOT TENNESSEE

ADMINISTRATIVE RECORD COVER SHEET

AR File Number __582__

TECHNICAL MEMORANDUM   CH2MHILL

Evaluation of Recreational Land Use Scenarios at Functional Unit 2, Memphis Depot

PREPARED FOR: Defense Logistic Agency, Memphis
                  Environmental Protection Agency Region IV
                  Tennessee Department of Environment and Conservation
                  Corps of Engineers, Huntsville

PREPARED BY: CH2M HILL

COPIES: File

DATE: March 16, 2000

Introduction

A risk assessment has been performed for Functional Unit (FU) 2, the golf course, at the Depot Main Installation assuming a recreational golfer exposure scenario. Alternative recreational land use scenarios for FU 2 are now being considered. This technical memorandum evaluates risks at the golf course for additional recreational scenarios such as jogging, playing soccer, and installation of playground equipment associated with use as a public park.

CH2M HILL in the *Streamlined Risk Assessment for Parcel 3* (CH2M HILL, January 1999) reported the risk to golfers and potential future industrial users and residences at the Depot golf course. Chemical data and a nature and extent evaluation is provided in the *Final Main Installation Remedial Investigation Report* (CH2M HILL, January 2000). Primary contaminants of concern at the golf course are pesticides, specifically dieldrin. The streamlined risk assessment performed for Parcel 3 included the golf course, a baseball diamond, and a small playground for children (CH2M HILL, January 1999). Risk estimation for the playground and the baseball diamond used the data collected within these areas (CH2M HILL, January 2000). The golf course was evaluated for golfing, future industrial and residential use.

This memorandum evaluates the potential human health risks from using the golf course as a general recreational use area such as a public park. Several exposure scenarios were evaluated for the golf course using the upper confidence limit at 95% above the mean value (UCL 95%) and the maximum detected concentrations as exposure point concentrations, as reported in the streamlined risk assessment.

Exposure Scenarios

As part of ongoing property transfer at the Depot, many areas of the Main Installation are being considered for future altered land uses. The golf course comprising FU 2 is being considered for use as a public park. The exposure scenarios were associated with the public

using any area of the golf course as a baseball diamond, soccer field, and/or a public jogging trail. The golf course was also evaluated as a future industrial facility and as a residential area. The exposures to a golfer were previously evaluated as part of the streamlined risk assessment. These previously developed exposure assumptions and estimated risks were included for comparison with exposure assumptions used for the newly developed scenarios. The intakes estimated for a unit concentration in soil for the other scenarios were compared with a golfer intake from the streamlined risk assessment. The risks and Health Indexes (HIs) for a golfer were adjusted using the relative percentage intake by the other receptors. Both soil ingestion and dermal contact were assumed under conservative exposure conditions for each scenario. The inhalation of dust scenario, though potentially complete, was not included in the risk assessment since this route of exposure typically contributes to <1% of the total dose. Attachment A includes the assumptions used for each scenario and the estimated intakes and risks. Table 1 summarized the risks and HIs for each scenario.

Golfer: The golfer exposure assumptions were previously presented in the Streamlined Risk Assessment. Golfers have been reported to place golf tees into their mouths, lick golf balls, or touch their mouths, food, or drinks with unwashed hands. These actions potentially increase soil consumption rates from that of dust or sand that they may ingest incidentally. A soil ingestion rate of 50 mg/day is assumed for a golfer, and 100% of this ingested soil is assumed to be contaminated soil. Golfers are assumed to wear shorts, short-sleeved shirts, socks, shoes, and hats. The assumed surface area (4,680 square centimeters [cm²]) available for contact with soils includes hands, half of the arms, and half of the legs. An adherence factor of 1 mg/cm² is assumed. Please refer to the Streamlined Risk Assessment for further details and rationale. The factors used are included in Attachment A.

Jogger (adult): A jogger is assumed to use the jogging trails 3 times a week for 50 weeks, resulting in an exposure frequency of 150 days/year. The soil ingestion rate is conservatively assumed to be 100 mg/day, with 50% originating from contaminated areas of the golf course. The jogger is assumed to be a local resident who is assumed to live in the same area for 30 years (exposure duration). Most of the skin surface area of hands, legs and half of arms (half-sleeved T-shirt) is assumed for exposure for soil adherence.

Child-Playground User: Exposure of a child in the playground was conservatively evaluated. The child is assumed to visit the park 5 days per week, for 50 weeks of the year (250 days/year), and is assumed to have a soil ingestion rate of 200 mg/day. Each visit is assumed to last for 4 hr. The children visiting the park are assumed to be up to 6 years of age. The skin surface area of 2,394 cm² is assumed to be available for soil contact and includes the surface area of hands, feet, and half each of arms and legs. The default ingestion rates provide for some conservatism in this risk scenario. Exposure factors are listed in detail in Attachment A.

Child-Baseball Player: Children are assumed to play baseball during the season once a week for 20 weeks (20 days/year). The soil ingestion rate during the ball game is assumed to be 200 mg/day. Children are assumed to play baseball for 8 years at the same park. The assumed clothing is a typical baseball uniform consisting of long pants, short-sleeved shirt, socks, shoes, and a cap. A skin surface area of 2,080 cm² is assumed to be available for soil contact and includes surface area of hands, feet, and half each of arms and legs. The default

ingestion rates allow some conservatism in this risk scenario. Exposure factors are listed in detail in Attachment A.

Youth Soccer Player: A soccer player scenario was developed using best professional judgement and conservative assumptions. The soccer players are assumed to include children of ages between 6 and 16 years of age and the exposure duration is assumed to be 10 years, with a youth body weight of 45 kg. Soccer season is assumed to last for 4 months with 20 days/month, a total of 80 days per season (year), and youths play soccer more frequently and for longer duration than younger children. The soil ingestion rate for these youths is assumed to be 150 mg/day, which is between the adult and child ingestion rates. The skin surface area available for contact is similar to an adult with surface area of half of arms, hands, and half of legs available for soil adherence (4,371 cm²). Exposure duration is assumed to last for 10 years. These are conservative assumptions for the soccer player scenario.

Industrial Worker: A future industrial worker is assumed to have a soil ingestion rate of 50 mg/day, for 250 days per year, with exposure duration of 25 years. Dermal contact with soils was estimated for the exposed skin area of hands, half of arms, and head (2,458 cm²/event), for 8 hrs/day.

Residential Adult and Child: Default assumptions are used for residential adults and children. Adults are assumed to have an ingestion rate of 100 mg/day, and children are assumed to have an ingestion rate of 200 mg/day. Exposure frequencies for both adults and children are assumed at 350 days/year. The exposure duration for adults is 30 years and a child is 6 years. Attachment A includes the assumptions used in calculating the intake factors.

Exposure Point Concentrations (EPCs): The reasonable maximum exposure (RME) risks and hazards were estimated using the UCL95% EPCs estimated for a golfer in the streamlined risk assessment. Additionally, the maximum detected concentrations across the golf course were selected to assess the worst-case risks. Results of both of these exposure assumptions for each exposure scenario are presented in Appendix A and summarized in Table 1.

Risk Evaluation Results

Assuming the acceptable risk range is 1 to 100 in a million (10^{-6} to 10^{-4}), and an exceptable HI is less than 1.0, the following recommendations can be made for the golf course future alternative land use, based on the observed concentrations presented in the RI.

1. Risks to a future **jogger** using the golf course as a jogging trail area are within EPA's acceptable risk criteria. Thus the potential risks from such future use are negligible.

2. If the area where a **playground** is established has concentrations similar to the maximum detected concentrations, risks and the HI to children are above the upper limit of the acceptable risks. Since the typical playground is small in area and pesticide concentrations are variable across the golf course, the maximum concentration-based assumption is more applicable for this scenario as an exposure unit. Thus the golf course may not be used to set up a playground, without remediation of the surface soil contamination.

3. Any area of the golf course may be used as a **baseball field or soccer field** under current conditions, as the risks and HIs to both of these receptors is within the acceptable risk criteria.

4. Without remediating the surface soil concentrations, the golf course is not fit for future **industrial** or **residential** use where workers or residences may spend an entire workday outdoors in contact with soil.

In conclusion, the golf course may be used as a golf course, baseball field, and soccer field. It may not used as a playground, industrial area, or residential area under the assumed exposure conditions evaluated in this risk assessment. The exposure assumptions used are generally conservative.

Table 1: Relative Risk Summaries for Recreational/Alternative Uses for the Depot Golf Course				
Exposure Scenario	**Health Risk at UCL95%**		**Health Risk at Maximum**	
	ELCR	**HI**	**ELCR**	**HI**
Adult Jogger	1.2E-05	0.05	2 6E-05	0.16
Child at Playground	4.8E-05	**1.1**	**1.1E-04**	**3.2**
Baseball Player - Child (4-12 yr)	1 6E-06	0.03	3 6E-06	0.1
Youth Soccer Player (6-16 yrs)	1.24E-05	0.17	2.82E-05	0.5
Industrial Worker – Adult	6.2E-05	**1.0**	**1.4E-04**	**2.9**
Residential – Adult	**2.0E-04**	**3.0**	**4.6E-04**	**9.0**
Residential – Child	**2.9E-04**	**6.6**	**6.6E-04**	**19.7**
Golfer – Adult	2.2E-05	0.1	5.0E-05	0.3
Note: ELCR = excess lifetime cancer risk HI = Hazard Index Bold values exceed ELCR of 10^{-4} or HI of 1				

Attachment A · FU 2 Recreational Users Risk Calculations
FUNCTIONAL UNIT 2 RECREATIONAL LAND USE RISK CALCULATIONS

Jogger/Runner - Adult

Exposure Scenario/Parameter	Ingestion Carcinogenic	Ingestion Non Carcinogenic	Dermal Parameter	Dermal Carcinogenic	Dermal Non carcinogenic	Total Ing+Dermal Carc-Intake	Total Ing+Dermal Noncarc	Relative Risk at UCL 95% Risk	Relative Risk at UCL 95% HI	Relative Risk at Max Conc Risk-Max	Relative Risk at Max Conc HI-Max
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1						
IR = Soil ingestion rate (mg/day)	100	100	SA = Skin Surface Area (cm2/event)	5419	5419						
FI = Fraction ingested from contaminated area (unitless)	0.5	0.5	AF = Soil Adherence factor (mg/cm3)	1	1						
ET = Exposure Time (hours/24 hr-day)	1	1	ABS = Absorption Factor (Unitless)	1	1						
EF = Exposure frequency (days/yr)	150	150	ET = Exposure Time (hours/24 hr-day)	1	1						
ED = Exposure duration (years)	30	30	EF = Exposure frequency (days/yr)	150	150						
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)	30	30						
BW = Body weight (kg)	70	70	CF = Conversion factor (unitless)	0.000001	0.000001						
AT = Averaging time(days/yr x years)	25550	10950	BW = Body weight (kg)	70	70						
			AT = Averaging time(days/yr x years)	25550	10950						
Intake =	6 24E-09	1 22E-08	Intake =	5 68E-07	1 33E-06	5 73E-07	1 34E-06	1 16E-05	0 05	2 6E-05	0 2
Percent Relative to Onsite Golfer (%)	07	07	Percent Relative to Onsite Golfer (%)	60	60	53	53				

Child - Playground

Exposure Scenario/Parameter	Ingestion Carcinogenic	Ingestion Non Carcinogenic	Dermal Parameter	Dermal Carcinogenic	Dermal Non carcinogenic	Total Ing+Dermal Carc-Intake	Total Ing+Dermal Noncarc	Risk	HI	Risk-Max	HI-Max
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1						
IR = Soil ingestion rate (mg/day)	200	200	SA = Skin Surface Area (cm2/event)	2394	2394						
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm3)	1	1						
ET = Exposure Time (hours/24 hr-day)	4	4	ABS = Absorption Factor (Unitless)	4	4						
EF = Exposure frequency (days/yr)	250	250	ET = Exposure Time (hours/24 hr-day)								
ED = Exposure duration (years)	6	6	EF = Exposure frequency (days/yr)	250	250						
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)	6	6						
BW = Body weight (kg)	15	15	CF = Conversion factor (unitless)	0.000001	0.000001						
AT = Averaging time(days/yr x years)	25550	2190	BW = Body weight (kg)	15	15						
			AT = Averaging time(days/yr x years)	25550	2190						
Intake =	7 83E-07	9 13E-06	Intake =	1 56E-06	1 82E-05	2 34E-06	2 74E-05	4 76E-05	1 08	1 08E-04	3 2
Percent Relative to Onsite Golfer (%)	698	2901	Percent Relative to Onsite Golfer (%)	164	619	216	1081				

Child/Youth - Baseball Player

Exposure Scenario/Parameter	Ingestion Carcinogenic	Ingestion Non Carcinogenic	Dermal Parameter	Dermal Carcinogenic	Dermal Non carcinogenic	Total Ing+Dermal Carc-Intake	Total Ing+Dermal Noncarc	Risk	HI	Risk-Max	HI-Max
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1						
IR = Soil ingestion rate (mg/day)	200	200	SA = Skin Surface Area (cm2/event)	2080	2080						
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm3)	1	1						
ET = Exposure Time (hours/24 hr workday)	2	2	ABS = Absorption Factor (Unitless)	2	2						
EF = Exposure frequency (days/yr)	20	20	ET = Exposure Time (hours/24 hr-day)								
ED = Exposure duration (years)	8	8	EF = Exposure frequency (days/yr)	20	20						
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)	8	8						
BW = Body weight (kg)	30	30	CF = Conversion factor (unitless)	0.000001	0.000001						
AT = Averaging time(days/yr x years)	25550	2920	BW = Body weight (kg)	30	30						
			AT = Averaging time(days/yr x years)	25550	2920						
Intake =	4 17E-08	3 65E-07	Intake =	3 62E-08	3 17E-07	7 79E-08	6 82E-07	1 58E-06	0 03	3 59E-06	0 1
Percent Relative to Onsite Golfer (%)	32	120	Percent Relative to Onsite Golfer (%)	4	14	7	27				

Child/Youth - Soccer Player (6-18 years)

Exposure Scenario/Parameter	Ingestion Carcinogenic	Ingestion Non Carcinogenic	Dermal Parameter	Dermal Carcinogenic	Dermal Non carcinogenic	Total Ing+Dermal Carc-Intake	Total Ing+Dermal Noncarc	Risk	HI	Risk-Max	HI-Max
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1						
IR = Soil ingestion rate (mg/day)	150	150	SA = Skin Surface Area (cm2/event)	4371	4371						
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm2)	1	1						
ET = Exposure Time (hours/24 hr workday)	4	4	ABS = Absorption Factor (Unitless)	4	4						
EF = Exposure frequency (days/yr)	80	80	ET = Exposure Time (hours/24 hr-day)								
ED = Exposure duration (years)	10	10	EF = Exposure frequency (days/yr)	80	80						
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)	10	10						
BW = Body weight (kg)	45	45	CF = Conversion factor (unitless)	0.000001	0.000001						
AT = Averaging time(days/yr x years)	25550	3650	BW = Body weight (kg)	45	45						
			AT = Averaging time(days/yr x years)	25550	3650						
Intake =	1 04E-07	7 31E-07	Intake =	5 07E-07	3 55E-06	6 11E-07	4 28E-06	1 24E-05	0 17	2.82E-05	0 5
Percent Relative to Onsite Golfer (%)	80	239	Percent Relative to Onsite Golfer (%)	53	160	56	169				

Attachment A, FU 2 Recreational Users Risk Calculations
FUNCTIONAL UNIT 2 RECREATIONAL LAND USE RISK CALCULATIONS

Industrial Worker – Adult

Exposure Scenario/Parameter (Ingestion)	Carcinogenic	Non Carcinogenic	Exposure Scenario/Parameter (Dermal)	Carcinogenic	Non carcinogenic	Total Ingestion+Dermal	Relative Risk at UCL95%	Relative Risk at Maximum Concentration
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1			
IR = Soil ingestion rate (mg/day)	50	50	SA = Skin Surface Area (cm2/event)	2458	2458			
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm3)	1	1			
ET = Exposure Time (hours/24 hr workday)	24	24	ABS = Absorption Factor (Unitless)	8	8			
EF = Exposure frequency (days/30 years)	250	250	ET = Exposure Time (hours/24 hr-day)	250	250			
ED = Exposure duration (years)	25	25	EF = Exposure frequency (days/yr)	25	25			
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)	25	25			
BW = Body weight (kg)	70	70	CF = Conversion factor (unitless)	0.000001	0.000001			
AT = Averaging time(days/yr x years)	25550	9125	BW = Body weight (kg)	70	70			
			AT = Averaging time(days/yr x years)	25550	9125			
Intake =	1.75E-07	4.89E-07	Intake =	2.86E-06	2.41E-05	3.04E-06 / 2.45E-05	6.17E-05 / 1.0	1.40E-04 / 2.9
Percent Relative to Onsite Golfer (%)	134	160	Percent Relative to Onsite Golfer	300	970	280 / 970		

Residential – Adult

Exposure Scenario/Parameter (Ingestion)	Carcinogenic	Non Carcinogenic	Exposure Scenario/Parameter (Dermal)	Carcinogenic	Non carcinogenic	Total Ingestion+Dermal	Relative Risk at UCL95%	Relative Risk at Maximum Concentration
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1			
IR = Soil ingestion rate (mg/day)	114.2	200	SA = Skin Surface Area (cm2/event)	1574	5419			
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm3)	1	1			
ET = Exposure Time (hours/24 hr workday)	24	24	ABS = Absorption Factor (Unitless)	24	24			
EF = Exposure frequency (days/30 years)	350	350	ET = Exposure Time (hours/24 hr-day)	350	350			
ED = Exposure duration (years)	30	30	EF = Exposure frequency (days/yr)	30	30			
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)					
BW = Body weight (kg)	70	70	CF = Conversion factor (unitless)	0.000001	0.000001			
AT = Averaging time(days/yr x years)	25550	10950	BW = Body weight (kg)	70	70			
			AT = Averaging time(days/yr x years)	25550	10950			
Intake =	6.70E-07	1.37E-06	Intake =	9.24E-06	7.42E-05	9.91E-06 / 7.56E-05	2.01E-04 / 3.0	4.57E-04 / 9.0
Percent Relative to Onsite Golfer (%)	512	449	Percent Relative to Onsite Golfer	970 / 1376	3338	914 / 2986		

Residential – Child

Exposure Scenario/Parameter (Ingestion)	Carcinogenic	Non Carcinogenic	Exposure Scenario/Parameter (Dermal)	Carcinogenic	Non carcinogenic	Total Ingestion+Dermal	Relative Risk at UCL95%	Relative Risk at Maximum Concentration
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1			
IR = Soil ingestion rate (mg/day)	200	200	SA = Skin Surface Area (cm2/event)	4371	4371			
FI = Fraction ingested from contaminated area (unitless)	1.00	1.00	AF = Soil Adherence factor (mg/cm3)	1	1			
ET = Exposure Time (hours/24 hr workday)	24	24	ABS = Absorption Factor (Unitless)	24	24			
EF = Exposure frequency (days/30 years)	350	350	ET = Exposure Time (hours/24 hr-day)	350	350			
ED = Exposure duration (years)	6	6	EF = Exposure frequency (days/yr)	6	6			
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)					
BW = Body weight (kg)	15	15	CF = Conversion factor (unitless)	0.000001	0.000001			
AT = Averaging time(days/yr x years)	25550	2190	BW = Body weight (kg)	15	15			
			AT = Averaging time(days/yr x years)	25550	2190			
Intake =	1.10E-06	1.28E-05	Intake =	1.31E-05	1.63E-04	1.42E-05 / 1.66E-04	2.88E-04 / 6.6	6.56E-04 / 19.7
Percent Relative to Onsite Golfer (%)	838	4188	Percent Relative to Onsite Golfer	1376	6881	1311 / 6556		

Onsite Golfer

Exposure Scenario/Parameter (Ingestion)	Carcinogenic	Non Carcinogenic	Exposure Scenario/Parameter (Dermal)	Carcinogenic	Non carcinogenic	Total Ingestion+Dermal	Relative Risk at UCL95%	Relative Risk at Maximum Concentration
Cs = concentration in soil (mg/kg)	1	1	Cs = concentration in soil (mg/kg)	1	1			
IR = Soil ingestion rate (mg/day)	50	50	SA = Skin Surface Area (cm2/event)	4371	4371			
FI = Fraction ingested from contaminated area (unitless)	1	1	AF = Soil Adherence factor (mg/cm3)	1	1			
ET = Exposure Time (hours/24 hr workday)	2	2	ABS = Absorption Factor (Unitless)	2	2			
EF = Exposure frequency (days/30 years)	4680	4680	ET = Exposure Time (hours/24 hr-day)	4680	4680			
ED = Exposure duration (years)	30	30	EF = Exposure frequency (days/yr)	30	30			
CF = Conversion factor (unitless)	0.000001	0.000001	ED = Exposure duration (years)					
BW = Body weight (kg)	70	70	CF = Conversion factor (unitless)	0.000001	0.000001			
AT = Averaging time(days/yr x years)	25550	10950	BW = Body weight (kg)	30	30			
			AT = Averaging time(days/yr x years)	25550	10950			
Intake =	1.31E-07	3.05E-07	Intake =	9.53E-07	2.22E-06	1.08E-06 / 2.53E-06	2.20E-05 / 0.1	5.00E-05 / 0.3
Percent Relative to Onsite Golfer (%)	100	100	Percent Relative to Onsite Golfer	100	100	100 / 100		

Intake Estimation formulas:

$$\text{Intake} = \frac{Cs \cdot IR \cdot FI \cdot EF \cdot ED \cdot CF}{BW \cdot AT}$$

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE